3.6 NOISE

Noise conditions vary considerably depending on location and time of day. Noise levels are relatively high in the cantonment area of SBMR and moderate in the cantonment area of PTA. Noise levels on training ranges are high during live-fire training but generally are low when no training is in progress. The Army receives an average of about six noise complaints per month, about half of which concern low-flying helicopters or fixed-wing aircraft. Noise from vehicles, small arms and heavy weapons firing, demolition charges, and simulators account for most of the remaining noise complaints.

3.6.1 Region of Influence

The ROI for noise sources depends on the intensity of noise generation. For most common noise sources, the ROI will be limited to areas within one-half mile of the noise source. High intensity noise sources, such as ordnance detonations, may have an ROI extending several miles from the noise source.

3.6.2 Resource Overview

Sound is caused by vibrations that generate waves of minute air pressure fluctuations in the surrounding air. Sound levels are typically measured using a logarithmic decibel (dB) scale. Measurements and descriptions of sounds are usually based on various combinations of the following factors:

- The vibration frequency characteristics of the sound, measured as sound wave cycles per second (Hertz [Hz]); this determines the "pitch" of a sound;
- The total sound energy being radiated by a source, usually reported as a sound power level;
- The actual air pressure changes experienced at a particular location, usually measured as a sound pressure level; the frequency characteristics and sound pressure level combine to determine the "loudness" of a sound at a particular location;
- The duration of a sound; and
- The changes in frequency characteristics or pressure levels through time.

Human hearing varies in sensitivity for different sound frequencies. The ear is most sensitive to sound frequencies between 800 and 8,000 Hz and is least sensitive to sound frequencies below 400 Hz or above 12,500 Hz. Consequently, several different frequency weighting schemes have been used to approximate the way the human ear responds to noise levels. The "A-weighted" decibel scale (dBA) is the most widely used for this purpose, with different dB adjustment values specified for each octave or 1/3 octave interval. Table 3-6 summarizes typical dBA levels for various noise sources and noise conditions.

Although the A-weighting scale is the most widely used decibel weighting procedure, other weighting scales have been developed. The C-weighted scale and unweighted decibel values are commonly used for blast noise, sonic booms, or other low frequency sounds capable of inducing vibrations in buildings or other structures. In addition, evaluations of blast noise or

Table 3-6
A-Weighted Decibel Values for Example Noise Sources

Characterization	dBA	Example Noise Source or Condition	Other Noise Examples
Threshold of pain	130	Surface detonation, 30 pounds (13.6 kilograms) of TNT at 1,000 feet (305 meters)	
Possible building damage	120	Mach 1.1 sonic boom under aircraft at 12,000 feet (3,658 meters)	Air raid siren at 50 feet (15 meters); B-1 flyover at 200 feet (61 meters)
	115	F/A-18 aircraft takeoff with afterburner at 1,600 feet (488 meters)	Commercial fireworks (5 pound (2.3 kilogram) charge) at 1,500 feet (457 meters)
	110	Peak crowd noise, pro football game, open stadium	Peak noise at firing position of rifle range
	100	F/A-18 aircraft departure climb out at 2,400 feet (732 meters)	Jackhammer at 10 feet (3 meters); B-52 flyover at 1,000 feet (305 meters)
Extremely noisy	95	Locomotive horn at 100 feet (30 meters); 2-mile range foghorn at 100 feet (30 meters)	Wood chipper processing tree branches at 30 feet (9.1 meters)
8-hour OSHA limit	90	Heavy truck, 35 mph (56 kmph) at 20 feet (6 meters); leaf blower at 5 feet (1.5 meters)	Person yelling at 5 feet (1.5 meters); dog barking at 5 feet (1.5 meters)
Very noisy	85	Power lawn mower at 5 feet (1.5 meters); city bus at 30 feet (9.1 meters)	Pneumatic wrench at 50 feet (15 meters); jet ski at 20 feet (6 meters)
Noisy	75	Street sweeper at 30 feet (9.1 meters); idling locomotive at 50 feet (15 meters)	Beach with medium wind and surf
	70	Auto, 35 mph (56 kmph) at 20 feet (6 meters); 300 feet (91 meters) from busy 6-lane freeway	Stream bank 10 feet (3 meters) from small/medium waterfall
Moderately noisy	65	Typical daytime busy downtown area conditions	Beach with light wind and surf; tree branches, light wind
	55	Typical daytime urban residential area away from major streets	Leaves, tall grass rustling in light/moderate wind
	50	Typical daytime suburban conditions	Open field, summer night, insects
Quiet	45	Typical rural area daytime conditions	
	40	Quiet suburban area at night	
Very quiet	30	Quiet rural area, winter night, no wind	Quiet bedroom at night, no air conditioner
	20	Empty recording studio	Barren area, no wind, water, insects, or animals
Barely audible	10	Audiometric testing booth	
Threshold of hearing	0		

Source: Data compiled by Tetra Tech staff.
Notes:
Indicated noise levels are average dBA levels for stationary noise sources or peak dBA levels for brief noise events and noise sources moving past a fixed point.
Average and peak dBA levels are not time-weighted 24-hour average Ldn values.
Decibel scales are not linear. Apparent loudness doubles for every 10 dBA increase in noise level, regardless of the dBA values.
Data compiled from various published sources, noise monitoring studies, and noise modeling analyses.

sonic boom events sometimes use a peak overpressure measurement. The peak overpressure normally is an unweighted decibel measurement for the dominant octave band or 1/3 octave band component of a sound. In most cases, the specific octave or 1/3 octave band for the peak overpressure measurement is not reported. The peak overpressure level will be slightly less than the corresponding composite unweighted decibel measurement.

Varying noise levels often are described in terms of the equivalent constant decibel level. Equivalent noise levels (Leq) are not a simple averaging of decibel values but are based on the cumulative acoustical energy associated with the component decibel values. Leq values sometimes are referred to as energy-averaged noise levels. As a consequence of the calculation procedure, high dB events contribute more to the Leq value than do low dB events. Leq values are used to develop single-value descriptions of average noise exposure over various periods of time. Such average noise exposure ratings often include additional weighting factors for potential annoyance due to time of day or other considerations. The Leq data used for these average noise exposure descriptors generally are based on A-weighted sound level measurements.

Average noise exposure over a 24-hour period often is presented as a day-night average sound level (Ldn). Ldn values are calculated from hourly Leq values, with the Leq values for the nighttime period (10 PM - 7 AM) increased by 10 dB to reflect the greater disturbance potential from nighttime noises. Because of the time period weighting, an Ldn value will be 6.4 dB greater than the corresponding 24-hour Leq value for a constant noise level. For most real noise conditions, the corresponding Ldn and 24-hour Leq values will differ by less than this.

Discrete noise events sometimes are characterized using the sound exposure level (SEL) descriptor. The SEL measure represents the cumulative (not average) sound exposure during a particular noise event, integrated with respect to a one-second time frame. SEL measurements are equivalent to the Leq value of a one-second noise event producing the same cumulative acoustic energy as the actual noise event being analyzed. In effect, an SEL measure "spreads" or "compresses" the noise event to fit a fixed one-second time interval. If the actual duration of the noise event is less than one second, the SEL value will be less than the Leq value for the event. If the duration of the noise event exceeds one second, the SEL value will exceed the Leq of the event. SEL values can be computed using any decibel weighting scheme.

Additional information concerning noise analyses is provided in Appendix H.

3.6.3 Federal and State Noise Standards and Guidelines

Department of Defense Noise Guidelines

The Department of Defense began developing noise evaluation programs in the early 1970s. Initial program development involved the Air Installation Compatible Use Zone (AICUZ) program for military airfields. Early application of the AICUZ program emphasized Air Force and Navy airfields. The Army implemented the program as the Installation Compatible Use Zone (ICUZ) program by addressing both airfield noise issues and other

major noise sources, such as weapons testing programs and firing ranges. Joint Air Force, Army, and Navy planning guidelines were issued in 1978 (DOD 1978). The 1978 guidelines use annual average Ldn values to categorize noise exposure conditions on military installations. The following three broad noise exposure zones are used as the basis for characterizing various land use compatibility conditions:

- Zone I—areas with Ldn levels below 65 dBA or 62 dBC;
- Zone II—areas with Ldn levels of 65-75 dB or 62-70 dBC; and
- Zone III—areas with Ldn levels above 75 dB or 70 dBC.

The guidelines indicate that all land uses are compatible with Zone I noise levels. Educational, medical, and residential land uses generally are not compatible with Zone II noise levels unless special acoustic treatments and designs are used to ensure acceptable interior noise levels. Acoustical insulation also may be needed for administrative and office facilities located in Zone II areas. Residential, medical, and educational land uses are not compatible with Zone III noise levels. Industrial, manufacturing, and office land uses may be acceptable in Zone III areas if special building designs and other measures are implemented.

The Army has recently supplemented the original 1978 guidelines to develop a more comprehensive Environmental Noise Management Program (ENMP). The ENMP program incorporates ICUZ evaluations as one component of the program. Other components of the ENMP include programs for handling noise complaints and undertaking supplemental noise evaluations when warranted by the nature of discrete noise events. Criteria for evaluation of noise levels have been expanded beyond the normal A-weighted Ldn descriptor to include the use of C-weighted Ldn values to characterize major blast noise sources and the use of peak unweighted decibel values to characterize small arms firing (Table 3-7). While AR 200-1 identifies the peak unweighted dB value as the method for characterizing noise from small arms firing, A-weighted Ldn values often are used instead as the preferred method for assessing land use compatibility issues (US Army 2002c).

USARHAW will use the ENMP to explore the following:

- Improvements in land use compatibility adjacent and proximal to USARHAW facilities;
- The feasibility of increasing acoustical insulation in structures or areas where noise-sensitive receptors reside, specifically in areas that are or may become exposed to Zone III and Zone II noise conditions, giving priority to family and troop housing areas affected by Zone III conditions; and
- Ways to improve notification to surrounding communities about the scheduling and nature of nighttime training exercises, which are possible sources of complaints about noise and vehicle activity. While enhanced public information programs will not reduce actual noise levels, they can help reduce the frequency of noise complaints.

Table 3-7
Noise Zones Defined in Army Regulation 200-1

Noise Zone	General Noise Sources, A-Weighted Ldn Range	Impulse Noise Sources, C-Weighted Ldn Range	Small Arms, Peak Unweighted dB Range	Percent of Population Highly Annoyed	Acceptability for Noise-Sensitive Land Uses
I	Up to 65 dBA Ldn	Up to 62 dBC Ldn	Up to 87 dB Peak	less than 15%	Acceptable
II	65 to 75 dBA Ldn	62 to 70 dBC Ldn	87 to 104 dB Peak	15% to 39%	Normally unacceptable
III	Over 75 dBA Ldn	Over 70 dBC Ldn	Over 104 dB Peak	Over 39%	Unacceptable

Notes:
Noise levels from all sources should be evaluated in terms of annual averages of the identified noise metric.
Noise from transportation sources (aircraft and vehicles) and common industrial sources should be evaluated using A-weighted Ldn values.
Noise from impulsive sources (such as armor, artillery, and demolition activities) should be evaluated using C-weighted Ldn values.
Noise from small arms ranges should be evaluated using peak unweighted dB values until the Z-weighting standard is adopted, at which time peak Z-weighted decibel values should be used.
Noise-sensitive land uses include housing, schools, and medical facilities.
Compatibility determinations for existing conditions and proposed actions should be supplemented by descriptions of projected noise increases and potential public reactions where:

(1) the noise environment is determined by a few infrequent but very high level noise sources (such as blast events over 110 dBC SEL);
(2) single event noise levels from the proposed action are 10 dB or more greater than existing levels;
(3) where the A-weighted Ldn is between 60 and 65 dBA and the proposed action would increase the Ldn by 3 dB or more;
(4) where the A-weighted Ldn is above 65 dBA and the proposed action would increase the Ldn by 1.5 dB or more.

Source:
US Army 1997b.

The Army Center for Health Promotion and Preventive Medicine (CHPPM) assists Army installations in developing environmental noise management plans. CHPPM also undertakes special noise studies to evaluate noise problems associated with various types of noise sources. When investigating noise conditions related to weapons firing or ordnance detonations, CHPPM typically measures peak unweighted decibel levels and/or C-weighted SEL levels. Table 3-8 summarizes the noise criteria most often used by CHPPM when evaluating blast noise issues.

The noise complaint program for Army installations in Hawai'i is managed through the Public Affairs Office, Community Relations Department at Schofield Barracks (phone number 808 655-2919 or access the Internet Web site at http://www.25idl.army.mil/). Noise and other complaints are logged with a brief checklist form to summarize the nature of the complaint and the activity or equipment that appears to be generating the complaint. Complaints regarding aircraft or helicopter operations are referred to the Aviation Division for investigation and follow-up. Complaints related to other noise sources or activities are referred to the appropriate unit or office for investigation and follow-up.

State Regulations

Hawai'i has adopted statewide noise standards that apply to fixed noise sources, construction equipment, and similar sources. The noise standards are phrased as property line noise limits and vary according to the zoning district of the impacted property. Separate noise standards have been established for non-impulse noise and impulse noise. The standards for non-impulse noise are summarized in Table 3-9. The standards for impulse noise are summarized in Table 3-10. All of the noise limits are specified as noise levels that can be exceeded no more than 10 percent of the time in any 20-minute period.

Available information on existing noise conditions at different Army installations is summarized in the appropriate chapter for each installation.

Table 3-8
CHPPM Blast Noise Assessment Criteria

Predicted Impulse Sound Level		Risk of Complaint	Recommended Action
Peak Unweighted dB Level	**C-Weighted SEL Value**		
Less than 115 dB	Less than 90 dBC	low risk of complaint	No restrictions
115 to 130 dB	90 to 105 dBC	moderate risk of complaint	Postpone non-critical tests if possible
130 to 140 dB	105 to 115 dBC	high risk of complaints; possibility of damage	Postpone all but extremely important tests
Over 140 dB	Over 115 dBC	threshold for permanent hearing damage; high risk of physiological and structural damage claims	Postpone all explosive operations

Notes:
CHPPM normally uses peak unweighted dB measurements to investigate blast noise complaint issues.
For rapid-fire test events with major weapons, noise level criteria should be reduced by 15 dB.
C-weighted SEL values often are used to predict the potential for sleep disturbance.

Source: US Army CHPPM 2001

Table 3-9
Hawai'i Community Noise Standards for Non-Impulse Noise

Zoning District Group	Example Zones	Daytime Noise Limit for Non-Impulse Noise (7 AM to 10 PM)	Nighttime Noise Limit for Non-Impulse Noise (10 PM to 7 AM)
CLASS A	Residential Conservation Preservation Open Space Public Space	L_{10} less than or equal to 55 dBA during any 20-minute period	L_{10} less than or equal to 45 dBA during any 20-minute period
CLASS B	Multi-family Dwellings Apartments Commercial Hotel Resort	L_{10} less than or equal to 60 dBA during any 20-minute period	L_{10} less than or equal to 50 dBA during any 20-minute period
CLASS C	Agriculture Country Industrial	L_{10} less than or equal to 70 dBA during any 20-minute period	L_{10} less than or equal to 70 dBA during any 20-minute period

Source: Hawai'i Administrative Rules, Title 11, Chapter 46

Notes:
L_{10} = noise level exceeded 10 percent of the time during the specified time interval.
Noise limits are based on the zoning district of the property affected by a noise source.
Class A, Class B, and Class C noise limits apply to any lands having zoning designations equivalent to the listed example zones.
For mixed zoning districts, the primary land use designation shall be used to determine the applicable noise limit.
Noise limits apply to any point at or beyond the property line of the noise source.
Noise sources covered by these noise limits include stationary noise sources and equipment used for agricultural, construction, or industrial activities.
Compliance with the non-impulse noise limits shall be based on A-weighted noise level measurements made with the instrument in the slow response setting (1 second integration).

Table 3-10
Hawai'i Community Noise Standards for Impulse Noise

Zoning District Group	Example Zones	Daytime Noise Limit for Impulse Noise (7 AM to 10 PM)	Nighttime Noise Limit for Impulse Noise (10 PM to 7 AM)
CLASS A	Residential Conservation Preservation Open Space Public Space	L_{10} less than or equal to 65 dBA during any 20-minute period	L_{10} less than or equal to 55 dBA during any 20-minute period
CLASS B	Multi-family Dwellings Apartments Commercial Hotel Resort	L_{10} less than or equal to 70 dBA during any 20-minute period	L_{10} less than or equal to 60 dBA during any 20-minute period
CLASS C	Agriculture Country Industrial	L_{10} less than or equal to 80 dBA during any 20-minute period	L_{10} less than or equal to 80 dBA during any 20-minute period

Source: Hawai'i Administrative Rules, Title 11, Chapter 46

Notes:
L_{10} = noise level exceeded 10 percent of the time during the specified time interval. Noise limits are based on the zoning district of the property affected by a noise source.
Class A, Class B, and Class C noise limits apply to any lands having zoning designations equivalent to the listed example zones.
For mixed zoning districts, the primary land use designation shall be used to determine the applicable noise limit.
Noise limits apply to any point at or beyond the property line of the noise source.
Noise sources covered by these noise limits include stationary noise sources and equipment used for agricultural, construction, or industrial activities. Compliance with the impulse noise limits shall be based on A-weighted noise level measurements made with the instrument in the fast response setting (125 millisecond integration).